

WRITTEN AMENDMENT
(Amendment based on Section 11)

To : Examiner of the Patent Office

1. Identification of the International Application
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4. Item to be Amended

Description and claims

5. Contents of Amendment

(1) As per the separate sheet, we amend "An objective lens driving device according to the present invention ... and a viscoelastic member provided in contact with the plurality of support members so as to reduce a resonance of the plurality of support members occurring when the lens holder is driven by the driving system." on page 3, line 26 to page 4, line 17 of the original description into "An objective lens driving device according to the present invention includes an objective lens provided for focusing light onto a recording medium so as to optically record information on or reproduce the information from the recording medium, a lens holder for holding the objective lens, a plurality of support members for supporting the lens holder so that the objective lens is freely movable in a focusing direction

perpendicular to a surface of the recording medium and a tracking direction perpendicular to the focusing direction, a driving system for driving the lens holder in the focusing direction and the tracking direction, and a fixing member provided with a viscoelastic member formed for holding the plurality of support members. Each of the plurality of support members includes a linear portion formed linearly so as to connect with the viscoelastic member provided in the fixing member and the lens holder, and at least one arm portion branching off from an intermediate area of the linear portion so as to reduce a resonance of each of the plurality of support members occurring when the lens holder is driven by the driving system. The linear portion is formed as a straight line between the lens holder and the viscoelastic member, the arm portion branches off from a part of the straight line of the linear portion, the arm portion has a T-shaped tip held by the viscoelastic member, and the linear portion has a bent portion formed in its end portion held by the viscoelastic member.”

(2) As per the separate sheet, we amend “In an objective lens driving device according to the present embodiment, ... it is preferable that the arm portion is formed to connect with the viscoelastic member provided in the fixing member.” on page 5, lines 12 to 24 of the original description into “In an objective lens driving device according to the present embodiment, the linear portion is formed as a straight line between the lens holder and the viscoelastic member, the arm portion branches off from a part of the straight line of the linear portion, the arm portion has a T-shaped tip held by the viscoelastic member, and the linear portion has a bent portion formed in its end portion held by the viscoelastic member. Since the tip of the arm portion held by the viscoelastic member is formed to have a T-shape and the bent portion is formed in the end portion of the linear portion held by the viscoelastic member, the resonance of the support members occurring when the lens holder is driven by the driving system can be suppressed more effectively by the T-shaped tip and the bent portion that are held by the viscoelastic member. Also, since the linear portion is formed as a straight line between the lens holder and the viscoelastic member and the arm portion branches off from the part of this straight line, the resonance of the support members can be reduced over the entire range from the fixing member to the lens holder.”

(3) As per the separate sheet, we cancel “In another objective lens driving device according to the present embodiment, a viscoelastic member is

provided in contact with the plurality of support members so as to reduce a resonance of the plurality of support members occurring when the lens holder is driven by the driving system. Thus, the resonance of the support members occurring when the lens holder is driven by the driving system is reduced by the viscoelastic member. Consequently, with a configuration that is substantially the same as the conventional configuration, it is possible to achieve the stability of a focusing driving and a tracking driving." on page 6, lines 7 to 15 of the original description.

(4) As per the separate sheet, we amend claim 1 and cancel claims 2 and 10.

6. List of Attached Documents

New sheets for pages 4 to 7 (translation: pages 3 to 6) of description

1

New sheets for pages 12 to 14 (translation: pages 10 to 12) of claims

1

into contact with these viscoelastic members 63. In this way, the vibrations of the support members 58, 59, 60 and 61 at the time of resonance are transmitted to the viscoelastic members 63, so that the resonance is reduced by a vibration damping function of the viscoelastic members 63.

5 However, with respect to displacement frequency characteristics when the movable portion is driven along the radial direction (tracking direction), undesired resonance occurs in the vicinity of the oscillation frequencies of the movable portion, i.e., 3 to 4 kHz as shown in FIG. 10.

10 In FIG. 11, a solid line indicates how the support members 58 and 59 are displaced at this time of resonance in an enlarged view. With a miniaturization of objective lens driving devices, it has become more difficult to enlarge portions where the support members contact the viscoelastic members 63. Accordingly, as shown in FIG. 11, the amplitude amount in the portions where the support members contact the viscoelastic members 63 are
15 small when the resonance occurs in the support members, making it difficult to reduce the resonance by the vibration damping function of the viscoelastic members 63. Furthermore, when such undesired resonance occurs, the control for driving the objective lens becomes unstable. This brings about phenomena such as tracking deviation, leading to a problem of signals not
20 being recorded or reproduced stably.

 It is an object of the present invention to provide an objective lens driving device that can reduce the resonance of support members, thus driving an objective lens in a stable manner.

25 Disclosure of Invention

 An objective lens driving device according to the present invention includes an objective lens provided for focusing light onto a recording medium so as to optically record information on or reproduce the information from the recording medium, a lens holder for holding the objective lens, a plurality of
30 support members for supporting the lens holder so that the objective lens is freely movable in a focusing direction perpendicular to a surface of the recording medium and a tracking direction perpendicular to the focusing direction, a driving system for driving the lens holder in the focusing direction and the tracking direction, and a fixing member provided with a
35 viscoelastic member formed for holding the plurality of support members. Each of the plurality of support members includes a linear portion formed linearly so as to connect with the viscoelastic member provided in the fixing

member and the lens holder, and at least one arm portion branching off from an intermediate area of the linear portion so as to reduce a resonance of each of the plurality of support members occurring when the lens holder is driven by the driving system. The linear portion is formed as a straight line
5 between the lens holder and the viscoelastic member, the arm portion branches off from a part of the straight line of the linear portion, the arm portion has a T-shaped tip held by the viscoelastic member, and the linear portion has a bent portion formed in its end portion held by the viscoelastic member.

Brief Description of Drawings

FIG. 1 is a perspective view showing a configuration of an objective lens driving device according to an embodiment.

FIG. 2 is a plan view showing a configuration of support members and viscoelastic members provided in the objective lens driving device
15 according to the embodiment.

FIG. 3 is a schematic view for describing resonance of the support members provided in the objective lens driving device according to the embodiment.

FIG. 4 is a graph showing a relationship between a resonance frequency and a gain of the support members provided in the objective lens driving device according to the embodiment.

FIG. 5 is a plan view showing a configuration of an objective lens driving device according to the embodiment.

FIG. 6 is a plan view showing a configuration of support members and viscoelastic members provided in another objective lens driving device
25 according to the embodiment.

FIG. 7 is a plan view showing a configuration of a yet another objective lens driving device according to the embodiment.

FIG. 8 is a plan view showing a configuration of a yet another objective lens driving device according to the embodiment.

FIG. 9 is a perspective view showing a configuration of a conventional objective lens driving device.

FIG. 10 is a graph showing a relationship between a resonance frequency and a gain of support members provided in the conventional objective lens driving device.
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FIG. 11 is a schematic view for describing resonance of the support

members provided in the conventional objective lens driving device.

Best Mode for Carrying Out the Invention

5 In an objective lens driving device according to the present
embodiment, the linear portion is formed as a straight line between the lens
holder and the viscoelastic member, the arm portion branches off from a part
of the straight line of the linear portion, the arm portion has a T-shaped tip
held by the viscoelastic member, and the linear portion has a bent portion
10 formed in its end portion held by the viscoelastic member. Since the tip of
the arm portion held by the viscoelastic member is formed to have a T-shape
and the bent portion is formed in the end portion of the linear portion held by
the viscoelastic member, the resonance of the support members occurring
when the lens holder is driven by the driving system can be suppressed more
effectively by the T-shaped tip and the bent portion that are held by the
15 viscoelastic member. Also, since the linear portion is formed as a straight
line between the lens holder and the viscoelastic member and the arm portion
branches off from the part of this straight line, the resonance of the support
members can be reduced over the entire range from the fixing member to the
lens holder.

20 It is preferable further to include a base for fixing the fixing member,
wherein the arm portion is formed to connect with a base viscoelastic member
provided in the base.

It is preferable that the arm portion is formed in a plane
perpendicular to the focusing direction.

25 It is preferable that the arm portion is formed in a plane
perpendicular to the tracking direction.

It is preferable that the at least one arm portion includes two arm
portions, one of the two arm portions is formed in a plane perpendicular to
the focusing direction, and the other is formed in a plane perpendicular to the
30 tracking direction.

It is preferable that the arm portion is formed to branch off from a
vicinity of a loop of a natural resonance of the support members.

It is preferable that a distance B between a position at which the arm
portion branches off from the linear portion and one end of the linear portion
35 is $1/5$ to $4/5$ of a total length L of the linear portion.

It is preferable that a distance B between a position at which the arm
portion branches off from the linear portion and one end of the linear portion

is $1/5$ to $1/2$ of a total length L of the linear portion.

The following is a description of the embodiment of the present invention, with reference to the accompanying drawings.

FIG. 1 is a perspective view showing a configuration of an objective lens driving device 100 according to the present embodiment, and FIG. 2 is a plan view showing a configuration of support members 8 and 9 and viscoelastic members 13 provided in the objective lens driving device 100.

Referring to FIG. 1, the objective lens driving device 100 includes a lens holder 2, to which an objective lens 1, a focusing coil 3 and a tracking coil 4 are fixed. These lens holder 2, the objective lens 1, the focusing coil 3 and the tracking coil 4 constitute a movable portion.

The focusing coil 3 has a winding axis along an optical axis direction shown in FIG. 1, and the tracking coil 4 has a winding axis along a circumferential direction, which is a direction perpendicular to the optical axis direction and a radial direction.

The objective lens driving device 100 is provided with four support members 8, 9, 10 and 11 made of an elastic material. One end of each of the support members 8, 9, 10 and 11 is joined to the lens holder 2, while the other end thereof is fixed to a fixing member 5. Since the lens holder 2 is cantilevered by the support members 8, 9, 10 and 11 as described above, it is freely movable within the elastic deformation range of the support members 8, 9, 10 and 11.

Magnets 6 and 7 are fixed to yoke portions 12a provided in a base 12.